Collectively Intelligent Systems

Jennifer H. Watkins[1]

From a psychological perspective, the laundry list of ways in which humans fail to make good decisions is extensive. Cognitive biases, as they are called, confound a sizable portion of our thinking. An individual may use a few salient examples of negative comments from her boss to conclude that she is going to lose her job (attribution bias). She subconsciously begins to seek out additional information confirming this belief, ignoring the fact that she just received high marks in her annual performance review (confirmation bias). Eventually, her fear over losing her job affects her performance enough that she is fired (self-fulfilling prophecy) and when she looks back she can say with total confidence that she saw it coming the whole time (hindsight).

When we consider individuals acting in a group, the situation only worsens. Indeed, if we are to believe the anecdotes of MacKay's mad crowds,[2] when people act together their worst characteristics are only magnified. More recently, this phenomenon has been characterized as groupthink, the bane of every boardroom. In fact, if we refer to the cognition literature, groupthink is only one of many socially based cognitive biases that boardroom executives should fear.

In contrast to these grim accounts of collective action, there are of course much rosier depictions, often denoted the wisdom of crowds.[3] Unlike research into cognitive biases, this description of humans gives respect to the human brain's sometimes amazing feats of synthesis. The human brain is an

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[1] Jen is a social scientist at Los Alamos National Laboratory where she works on the Collective Decision Making Systems project available at http://cdms.lanl.gov. This project investigates how the design of systems (especially those online) supports accurate and reliable decision making in groups.

[2] MacKay, C. (1980). *Extraordinary Popular Delusions and the Madness of Crowds*. New York: Harmony Books. (Original work published 1841).

[3] refers to Surowiecki, J. (2004). *The Wisdom of Crowds*. New York: Doubleday.

unparalleled machine for tracking a vast number of subtle environmental cues to determine a future state. When occurring within a group, the evidence for these feats of insight are captured primarily in anecdotes as in the following:

> The IEM [Iowa Electronic Markets[4]] continued its track record of predicting election vote-share, predicting Bush's victory within 1.1 percent of the actual outcome. At midnight on Nov. 1, the IEM's vote share market had Bush earning 50.45 percent of the popular vote, compared to 49.55 percent for Kerry. The actual vote count as of Nov. 4 showed 51.54 percent for Bush and 48.55 percent for Kerry. [5]

So how can humans at once be totally biased, manipulable thinkers and wise, sophisticated problem-solvers? The answer exists in considering the system in which the problem is posed. It is the thinkers and their environment as a whole that work to hinder or support the production of the desired answer, whether that answer is a point of fact or a near supernatural prescience, as in the example above. For example, if we phrase a factual question as so:

Michigan, the state that was home to Henry Ford, the inventor of the automobile assembly line, remains today the home of major car manufacturers. What is the capital of Michigan?

One is likely to incorrectly name Detroit. By priming with details about Detroit, one is led away from the correct answer (Lansing is the capital of Michigan).

In this example, the priming leads to an incorrect answer but it could also be used to guide a person to the correct answer (what might be called a hint). In this case, it is the person plus the context that develops the correct answer. In a similar way, we can design systems that, when paired with a collective, create good decisions that the individuals would not have developed on their own. This system would structure both the embodied intelligence (from the physical environment) and the socially situated intelligence (from

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[4] available at http://www.biz.uiowa.edu/iem/

[5] McCrory, G. (2004, November 5). Iowa Electronic Markets Forecasted Bush Win in Presidential Election. *University of Iowa News Service.* Retrieved November 9, 2007, from <http://www.news-releases.uiowa.edu/2004/november/110504iem_wrap.html>.

social interaction) to the extent necessary to create the desired outcome (i.e., a good decision). Together, the collective and the system could be called a collectively intelligent system.

A collectively intelligent system need not be computer-based. For example, the Delphi method, whereby experts iteratively and anonymously contribute insight to work toward a combined collective view, is an asynchronous process that is often conducted through the mail. The system is collectively intelligent in that it avoids groupthink and the other cognitive biases that can occur in face-to-face discussions. The goal is to integrate the diversity of the collective, not to achieve consensus through the suppression of dissent.

While not all the systems are computer-based, the complimentary strengths and weaknesses of humans and computers give computer-based systems a particular allure. The Internet has spawned numerous well-known applications that facilitate collectively intelligent systems. These systems include document rankings, folksonomies, recommender systems, vote systems, open source software, wikis, and prediction markets.[6] Each system offers a unique way to solve a problem or make a decision collectively. This requires two things of the system: a method to elicit the information from the appropriate individuals and method to aggregate that information so as to make it useful. The elegance of each system is in its ability to evoke the necessary answer. Whether intentional or evolutionary, the design of these systems allows them to exploit the power of the human mind to solve problems.

A collectively intelligent system can be placed into one of three categories based on the utilization of the collective:

1. **The collective is as smart as the smartest individual in the collective**

[6] For an in-depth review of all seven system types see Watkins, J. H. & Rodriguez, M. A. (August 2007). A survey of web-based collective decision making systems. *Human Complex Systems. Lake Arrowhead Conference, 2007*. Paper JHW2007-1. http://repositories.cdlib.org/hcs/WorkingPapers2/JHW2007-1

This system type is exemplified by Innocentive.[7] Here a challenge in a corporation is opened up beyond the institution's walls by posting it to the Innocentive site. Anyone can access the site and choose to work on the problem. The corporation compensates the one who most satisfactorily solves the problem. Here, the purpose of the collective is to provide the diversity out of which the smartest person for the particular problem can self-select. In other words, the collective is needed if the expert has not been identified, or changes from problem to problem.

2. **The collective is as smart as the sum of the individuals in the collective**[8]

The Iowa Electronic Markets are a good example of this phenomenon. In these prediction markets, every participant alters the decision of the whole through the buying and selling of stocks. The price at which the stocks are traded can be interpreted as the likelihood (a probability) the collective attributes to the event occurring. Like traditional markets, the "invisible hand" governs prediction markets. This metaphor refers essentially a feedback mechanism that urges the contribution of the best information simultaneous to its aggregation. The result is potentially astounding prescience.

3. **The collective is smarter than sum of the individuals in the collective**

This elusive category refers to decisions that transcend the combined intelligence of the collective to produce synergistic intelligence. Here the combined contributions of the collective provide a product that is more valuable than the contributions themselves. It is this use of collectively intelligent systems that represents the greatest boon to mankind.

In sum, my vision for collective intelligence is the refinement of collectively intelligent systems design such that even the most complex problems will yield to the efforts of the collective.

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[7] available at http://www.innocentive.com

[8] For more examples of the first two categories, see Sunstein, C. R. (2006). *Infotopia: How many minds produce knowledge.* Oxford: Oxford University Press.